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The Role of Epigenetic Mechanisms in Skeletal Muscle Aging

Abstract

The article examines the role of epigenetic mechanisms – specifically DNA methylation, histone modifications and miRNAs – in the aging process of skeletal muscle and analyzes the potential of physical activity to interfere with these mechanisms. Studies conducted in different age groups show that regular physical exercise enhances muscle regeneration by regulating gene expression through epigenetic pathways and prevents degenerative changes associated with aging. Analyses conducted at the molecular level have proven that physical activity restores muscle proteosynthesis and structural stability by stimulating demethylation at CpG sites. At the same time, the changes observed in the expression of miRNAs are of great importance for muscle regeneration and metabolic stability. It has been studied that physical activity can regulate a large part of these changes. In conclusion, the article highlights the proposal of targeting epigenetic modifications through physical activity as an effective and non-pharmacological strategy against the biological processes of aging.

Keywords: *skeletal muscle aging, epigenetic mechanisms, DNA methylation, miRNA, muscle regeneration*

Introduction

Skeletal muscle aging, a reality of the modern era, is being studied as one of the main aspects of biological aging and not only genetic factors, but also epigenetic regulatory mechanisms play an important role in this process. As the aging process causes functional impairment of a number of systems in human physiology, skeletal muscle mass and strength decrease, which is known as sarcopenia. Sarcopenia is the age-related loss of muscle mass that can seriously reduce the mobility, quality of life and independence of individuals. Recent studies have shown that these changes can be explained not only by genetic factors, but also by epigenetic mechanisms – that is, the influence of the environment and lifestyle on gene expression. Epigenetic modifications – methylation, histone modifications and the activity of microRNAs – are among the main mechanisms that regulate cell function. These changes play an important role in the aging process by affecting the regenerative capacity of muscle cells, energy metabolism and stress response mechanisms. Interestingly, these mechanisms are dynamic and certain lifestyle changes, especially physical activity can improve the functional state of skeletal muscle by affecting the epigenetic state. Regular exercise, especially strength training can change gene expression in muscle cells and prevent age-related atrophy. In addition, physical activity can also lead to a decrease in inflammatory processes in muscles, improved mitochondrial function and increased cell proliferation. Recent studies suggest that epigenetic modifications are one of the main reasons behind these changes (Zykovich et al., 2014).

Research

DNA methylation is a key epigenetic mechanism involved in the regulation of gene expression. As a result of genome-wide analyses by Zykovich et al. (2014), it was determined that age-related changes in methylation levels occur in skeletal muscle and these changes negatively affect the energy balance and regeneration capacity of the cell. **Histone modifications and miRNAs** also

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play an important role in muscle aging. Sharples (2016) showed that muscle-specific microRNAs such as miR-1 and miR-206 regulate muscle differentiation and their expression changes with age. At the same time, histone acetylation and deacetylation can affect gene transcription, reducing or increasing the proliferative capacity of muscle cells. **Studies on the epigenetic effects** of physical activity have shown that strength and endurance training have the ability to alter the "epigenetic memory" of muscles. A study by Seaborne (2018) noted that muscles can be epigenetically programmed in response to past exercise and this memory is involved in future adaptations. Other studies have shown that exercise activates intracellular signaling pathways – s pecifically PGC-1α, AMPK, and mTOR signaling – which increases gene expression and supports muscle homeostasis (McGee & Hargreaves, 2020). These changes are observed in the maintenance of mitochondrial biogenesis, anti-inflammatory status, and protein balance in muscle. Most researchers also note that the effects of physical activity may vary depending on individual factors such as gender, age, and genetic background.

Table 1.
Results from the conducted studies.

Epigenetic Factors	Effect of Physical Activity Related	Genes and Signaling	Pathways Source
DNA methylation	Decreases or normalizes	PGC-1α, MyoD	Zykovich et al., 2014
Histone acetylation	Increases (activates gene expression)	SIRT1, HDAC, MEF2C	McGee & Hargreaves, 2020
miRNAs (miR-1, miR-206)	Expression level is regulated	Myf5, Pax7	Sharples et al., 2016

Essentially, epigenetic mechanisms are the fundamental molecular processes that regulate gene expression without altering the genetic code. The most important epigenetic mechanisms in skeletal muscle aging can be divided into three groups: DNA methylation, histone modifications and expression of microRNAs (miRNAs). DNA methylation is a mechanism that regulates gene transcription by adding methyl groups (CH_3) to cytosine nucleotides. Skeletal muscle is characterized by increased methylation levels associated with aging, which impairs the cells' ability to produce energy, synthesize proteins, and regenerate (Zykovich et al., 2014). These changes, which reduce the transcriptional potential of muscle cells, play an important role in the development of sarcopenia. Histones are proteins involved in the structuring of genetic material (DNA). As a result of their chemical modifications, such as acetylation, methylation, and phosphorylation, the chromatin structure changes, which in turn affects gene expression. During aging, muscle cells experience a decrease in histone acetylation, which leads to the silencing of genes involved in muscle regeneration (Sharples et al., 2016). And, due to the increased activity of histone deacetylase enzymes, a weakening of the ability to proliferate is observed. miRNAs are small non-coding molecules that regulate the stability or degradation of mRNAs. The expression of muscle-specific miRNAs, in particular miR-1, miR-133 and miR-206, decreases with age (Sharples et al., 2016). These miRNAs regulate the activity of genes involved in muscle regeneration, differentiation and cell cycle. Changes in their expression levels can lead to a decrease in muscle mass and impaired regeneration capacity. Interplay of epigenetic mechanisms. These mechanisms interact with each other. For example, miRNAs can target both DNA methyltransferase (DNMT) enzymes and histone modification enzymes. At the same time, histone modifications can also regulate the methylation process at specific gene regions. This interaction creates a complex epigenetic regulatory network, which explains the multifactorial nature of aging-related muscle changes (Seaborne et al., 2018). Skeletal muscles play a key role in maintaining the movement and metabolic homeostasis of the human body. However, with aging, these muscles experience loss of strength, atrophy and reduced regeneration capacity.

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Table 2.
Effects of Physical Activity on Muscle Function through Epigenetic Pathways.

Graph/Scheme	Descriptive	Benefit
"Effect of Physical Activity on Muscle Function via Epigenetic Pathways"	Physical activity → DNA demethylation → miRNA expression changes → Muscle regeneration	Visual explanation of the process
"Age-related CpG site changes"	Changes in CpG count in young and old (bar graph)	Comparison based on statistical analysis
"Epigenetic Memory" model	Effect of prior exercise on gene expression	Explanation of the concept of epigenetic memory

Although these changes have traditionally been explained by hormones, oxidative stress, and disruptions in protein synthesis, in recent years the role of epigenetic mechanisms in these processes has come into greater focus. Thus, epigenetic modifications – particularly DNA methylation, histone modifications and miRNAs – influence the functional state of muscle tissues by altering gene expression.

Conclusion

A number of real-world studies have been conducted to show how epigenetic changes in skeletal muscle change in response to physical activity. In an analysis of individuals aged 54–77 years by Zykovich (2014), it was shown that 5962 CpG sites were differentially methylated in muscle tissue of older individuals compared to young individuals. Most of these changes were located in regions that regulate transcription, indicating the epigenetic influence of aging on gene expression. Another study by Seaborne et al. (2018) involved 8 young men undergoing a 7-week strength training program, followed by a 7-week rest period and a retraining phase.

Table 3.
Epigenetic changes in response to activity (Seaborne et al., 2018).

Research phase	CpG demethylation count	Key observation
Exercise 1 (7 weeks)	17,365	Increase in gene expression
Passivity (7 weeks)	Decrease in demethylation	Decrease in gene expression
Exercise 2 (7 weeks)	27,155	Strong response with epigenetic memory

As a result, demethylation of 17,365 CpG sites was observed in muscle cells after exercise and it was shown that these epigenetic changes were partially restored during the period of inactivity, but that the subsequent exercise resulted in stronger gene expression than the previous exercise. These observations suggest that muscles have an “epigenetic memory” and that previous exercise experiences have a long-term effect on gene expression. Sharples et al. (2016) compared miRNA expression in muscle biopsies from elderly (60–75 years) and young (20–30 years) individuals and confirmed that muscle-specific miRNAs such as miR-1, miR-133a, and miR-206 decreased with age. These differences were partially reversed by a vigorous exercise program. These results suggest that physical activity does not only induce short-term physiological changes, but also optimizes muscle function through long-term epigenetic programming. Thus, epigenetic changes associated with skeletal muscle aging can be regulated to some extent and physical activity is one of the key factors that positively influences this process.

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References

1. McGee, S. L., & Hargreaves, M. (2020). Exercise and skeletal muscle epigenetics: a transgenerational perspective. *Cell Metabolism*, 31(5), 825–826. https://doi.org/10.1016/j.cmet.2020.04.015
2. Seaborne, R. A., Strauss, J., Cocks, M., Shepherd, S., O'Brien, T. D., van Someren, K. A., ... & Sharples, A. P. (2018). Human skeletal muscle possesses an epigenetic memory of hypertrophy. *Scientific Reports*, 8(1), 1898. https://doi.org/10.1038/s41598-018-20287-3
3. Sharples, A. P., Stewart, C. E., & Seaborne, R. A. (2016). Does skeletal muscle have an 'epi'-memory? The role of epigenetics in nutritional programming, metabolic disease, aging, and exercise. *Aging Cell*, 15(4), 603–616. https://doi.org/10.1111/acel.12486
4. Zykovich, A., Hubbard, A., Flynn, J. M., Tarnopolsky, M., Fraga, M. F., Kerksick, C., ... & Melov, S. (2014). Genome-wide DNA methylation changes with age in disease-free human skeletal muscle. *Aging Cell*, 13(2), 360–366. https://doi.org/10.1111/acel.12164
5. Nilsson, E. C., Wåhlén, K., Lindgren, T. E., et al. (2019). Altered global DNA methylation and differential gene expression in skeletal muscle of physically active men. *Epigenetics*, 14(10), 1051–1063. https://doi.org/10.1080/15592294.2019.1638701
6. Laker, R. C., & Yan, Z. (2018). Exercise and skeletal muscle epigenetics: An overview of current research. Progress in Molecular Biology and Translational Science, 160, 311–346. https://doi.org/10.1016/bs.pmbts.2018.08.002
7. Voisin, S., Eynon, N., Yan, X., & Bishop, D. J. (2015). Exercise training and DNA methylation in humans. Acta Physiologica, 213(1), 39–59. https://doi.org/10.1111/apha.12414
8. Lundberg, T. R., & Fernandez-Gonzalo, R. (2021). Muscle memory and epigenetics: Does strength training leave an epigenetic imprint? Journal of Applied Physiology, 130(6), 1762–1769 https://doi.org/10.1152/japplphysiol.00875.2020
9. Sailani, M. R., et al. (2019). DNA methylation patterns associated with exercise-induced changes in human skeletal muscle. Clinical Epigenetics, 11(1), 64. https://doi.org/10.1186/s13148-019-0664-1
10. Barres, R., & Zierath, J. R. (2016). The role of epigenetic modifications in transcriptional regulation in skeletal muscle. Journal of Applied Physiology, 120(1), 62–69. https://doi.org/10.1152/japplphysiol.00756.2015
11. Turner, D. C., et al. (2019). Comparative transcriptome and methylome analysis in human skeletal muscle following resistance training. Scientific Reports, 9, 13150. https://doi.org/10.1038/s41598-019-49532-1
12. Pillon, N. J., et al. (2020). Transcriptomic profiling of skeletal muscle adaptations to exercise and inactivity. Nature Communications, 11, 470. https://doi.org/10.1038/s41467-019-13869-w
13. Dungan, C. M., et al. (2021). Exercise and epigenetic regulation in skeletal muscle: An update. Journal of Applied Physiology, 130(6), 1782–1799. https://doi.org/10.1152/japplphysiol.00042.2021
14. Rowlands, D. S., et al. (2014). Epigenetic regulation of gene expression in human skeletal muscle: The role of histone modifications. Sports Medicine, 44(5), 687–703. https://doi.org/10.1007/s40279-014-0161-9
15. Denham, J., et al. (2015). Exercise and epigenetic inheritance of disease risk. Acta Physiologica, 213(1), 39–59. https://doi.org/10.1111/apha.12433

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Treatment and Prevention of Mastitis in High-Yielding Cows

Abstract

The article deals with the study of the prevalence of acute mastitis among cows in the farms of the Republic of Azerbaijan and the improvement of the effectiveness of treatment measures based on complex therapy with pathogenetic, symptomatic and etiological effects in the treatment of this disease. The therapeutic efficacy of Roxacin-M 0.1% solution in the treatment of subclinical mastitis in dairy cows was 93% and the effectiveness of Roxacin-M and Masticort Phyto preparations in combination with other mastitis treatments was investigated and applied.

The direct causes of mastitis are mechanical damage to mammary gland tissues and their infection. As a result of improving the functional properties of the mammary gland (milking rate, resistance of the mammary gland to diseases), it is possible to use milking equipment efficiently and reduce the time spent on milking. The incidence of mastitis depends on both productivity indicators and technological factors. Thus, when the productivity of animals is low, the percentage of cows with mastitis also decreases.

Keywords: *cow, mastitis, mammary gland, subclinical, therapy, inflammation*

Introduction

There are a fairly large number of factors affecting the development of mastitis (inflammation of the mammary gland) in animals. Today, veterinarians and specialists working in this field are working on the issues raised in order to identify the causes leading to the development of mastitis.

Research conducted over several years has shown that mastitis in animals occurs mainly for two reasons: endogenous and exogenous. It is also necessary to note the following factors for the development of this disease: complicated course of the birth process, gynecological diseases, violation of sanitary and hygienic rules established in animals during childbirth, improper composition of the feed ration, mechanical shocks during milking, pathogenic microflora.

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The main purpose and objectives of the study:

To determine the prevalence of acute mastitis among cows; to analyze the clinical forms and features of the course of mastitis; to evaluate existing treatment methods and comparatively study their effectiveness; to develop a complex therapy regimen consisting of pathogenetic, symptomatic and etiologically effective drugs; to determine the therapeutic efficacy and duration of action of the developed treatment regimen; to substantiate the application of the proposed treatment measures in farms.

The etiology of the disease is often associated with the introduction of infection against the background of a weakened immune system (Danmallam, & Pimenov, 2017; Golubev, Pavlov, & Sukhova, 2001). Infection of the mammary gland parenchyma occurs mainly as a result of the entry of pathogenic bacteria through the teat canal.

Research

In the works of Bozhenov E.S. and Sviridenko G.M., it is noted that about 90 types of "conditionally pathogenic" microorganisms that are the causative agents of mastitis are relevant. These microorganisms can enter the mammary gland galactogenically (through the milk duct), as well as lymphogenously and hematogenously, especially during wounds, when inflammatory processes develop in other organs and tissues (endometritis, gastroenteritis) (Kartashova, Kirgizova, & Isaykina, 2004; Klimov, & Slobodyanik, 2012).

According to different authors (Ahmadov, Isgandarov, 2010; Ajuwape, Roberts, Solarin, & Adetosoye, 2005), staphylococci are the most etiologically important of these bacteria, followed by streptococci and Escherichia coli, the role of other microorganisms is secondary.

Unlike other organs, the mammary gland does not only serve the body, but often even hinders it. It removes from the body the most valuable elements that enter the blood for other organs and tissues and their components, often weakening them and can lead to the death of the organism as a result of exhaustion; the mammary gland prevents the animal from moving. Like the genitals, the mammary gland should always be considered as an organ of the species, it functions only in natural conditions during the period of suckling the cub; it evolves in connection with birth and involutes when the cub no longer needs its mother's milk.

The mammary gland is of interest to zootechnicians and veterinarians as an organ that produces an indispensable food product (colostrum) for newborns and provides the food industry with an important raw material - milk. According to various authors, staphylococci are detected in 25-50% of cases of mastitis in Tanzania, Bangladesh, Ethiopia, Pakistan and India (Alawa, Ngele, & Ogwu, 2000; Golubev, Pavlov, & Sukhova, 2001).

In the CIS countries, pathogenic staphylococci are found in 20-40% of cases of mammary gland inflammation in small ruminants (Kartashova, Kirgizova, & Isaykina, 2004). As mentioned, mastitis is an inflammation of the mammary gland parenchyma, characterized by physicochemical and bacteriological changes in milk, as well as the development of pathologies in the gland (Klimov, & Slobodyanik, 2012; Ahmadov, & Isgandarov, 2010). This disease can have both infectious and non-infectious etiology, but bacterial and other pathogens have a major impact on the pathogenesis and progression of the disease. These include various bacteria (Ajuwape, Roberts, Solarin, & Adetosoye, 2005), viruses, mycoplasmas, and yeast fungi. Due to mastitis in cattle, milk production suffers great economic losses in many countries of the world, including the United States, Pakistan and other places.

Mastitis is one of the main problems of dairy cattle breeding. One of the main reasons for the occurrence of mastitis in cows is the genetic predisposition and the fact that animals show various forms of resistance depending on their sex, intraspecific and lineage. This is confirmed by morphological and interior indicators (Gomboyev, 2005).

According to studies, due to shortcomings in the selection of dairy cattle and their transfer to machine milking, more than 10% of cows are eliminated during selection due to atrophy of one or two mammary glands, taking into account the shape of the mammary gland and the size of the udder.

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Against the background of intensive development of dairy farming and the constant increase in milk yield, deficiencies in feeding, violation of housing conditions and improper milking technology are considered important problems. As a result, changes occur in the general physiological state of the animal's body and in the mammary gland (Klimov, 2009).

According to veterinary statistics, up to 75% of mastitis cases observed with clinical signs occur during lactation. The prevalence of mastitis is due to the year-round confinement of animals. The highest incidence of acute mastitis was observed in January-March, which is associated with the lack of valuable feed and active movement. The percentage of mastitis cases was lowest during the grazing period (May-September). According to the observations, in 69% of cases, one lobe of the mammary gland is involved in the inflammatory process, and in rare cases (29%) - two or more lobes. At the same time, in more cases (61.4%) it was observed that the anterior lobes of the mammary gland of cows were damaged (Kolenchukova, n.d.).

According to the data in the outpatient journal, mastitis occurred on average 26% in the postpartum period, 37% in the later stages of lactation, and 37% during the cessation of milking and the transition to the dry period.

The main causes of mastitis are as follows: Lack of selection and breeding work on the shape of the mammary gland and the structure of the teats, which in many cases leads to violations of the technology of milking by machine; Incomplete and irrational organization of protein-carbohydrate-mineral feeding, especially at the initial stage of milking, which leads to the development of ketosis and acidosis in animals (Nasibov, & Verdiyeva, 2023).

The development of methods for studying and evaluating the morphological and functional properties of the mammary gland is of great practical importance.

Our analysis of the composition of the microflora in the secretion of the mammary gland showed that the following microbial cultures are mainly found during subclinical mastitis: staphylococci, streptococci, E. coli, proteus, blue-green bacilli (Pseudomonas aeruginosa), Bacillus and fungi.

Experiments were conducted to determine the therapeutic efficacy of the drug Roxacin-M.

Table 1. Therapeutic efficacy of Roxacin-M in cows with mastitis.

Experimental groups	Preparations	Dose (ml)	Number of sick animals	Recovered animals (after 3 days)	Recovered animals (after 5 days)
First experiment	Roxacin-M Fluxirol	10 intercisternal) every 12 hours 22 (intravenously) for 3 days	6	3	6
Second experiment	Roxacin-M Recefur PS-200	15 (intercisternal) every 12 hours 17 (subcutaneous) Once	6	4	6
Control group	Masticort - Phyto Resefur PS-200	10 intercisternal) Every 12 hours 17 (subcutaneous) Once	6	4	6

According to the available data, on the third day of treatment, the number of recovered animals in the second experimental and control groups was 4, while in the first experimental group this figure was 3. On the fifth day of treatment, complete recovery was observed in all three groups (Nasibov, Ahmadov, & Verdiyeva, 2014).

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Conclusion

Cows throughout the lactation period are subjected to diagnostic measures every month, taking into account the relevant requirements, in order to determine the increase in the number of somatic cells in the mammary gland secretion, and various indirect methods are still used to determine their number.

References

1. Ahmadov, A. G., & Isgandarov, T. B. (2010). *Veterinary obstetrics, gynecology, artificial insemination of agricultural animals and embryo transplantation (transfer)*, 194–196.
2. Ajuwape, A. T. P., Roberts, A. A., Solarin, O. O., & Adetosoye, A. I. (2005). Bacteriological and haematological studies of clinical mastitis in goats in Ibadan, Oyo State, Nigeria. *Tropical Veterinarian, 60*, 307–310.
3. Alawa, J. P., Ngele, M. B., & Ogwu, D. (2000). Chronic caprine mastitis in Nigerian goat breeds: Microbiological flora and histopathological findings. *Small Ruminant Research, 35*, 203–207.
4. Danmallam, F. A., & Pimenov, N. V. (2017). Vidovoy sostav mikroflory, vydelennoy iz molochnoy zhelezy zdorovykh i bol'nykh mastitom koz. *Veterinariya i Zootekhniya, (4)*, 6–12.
5. Golubev, M. I., Pavlov, V. P., & Sukhova, M. V. (2001). Sredstva i sposoby razrusheniya mekhanizma peredachi vozbuditeley infektsiy i invaziy. In *Problemy veterinarii na rubezhe vekov: Sbornik statey*, 286–288.
6. Gomboyev, B. N. (2005). *Razrabotka i sovershenstvovaniye metodov terapii i profilaktiki* [Dissertatsiya, Blagoveshchensk]. 20.
7. Kartashova, O. L., Kirgizova, S. B., & Isaykina, Ye. Yu. (2004). Diagnostika skrytykh form mastita u korov. *Veterinariya, (10)*, 32–35.
8. Klimov, N. T., & Slobodyanik, V. I. (2012). *Prakticheskoye rukovodstvo po bor'be s mastitami korov* (87 s.). Voronezh.
9. Klimov, N. T. (2009). *Eksperimental'naya i klinicheskaya farmakologiya lekarstvennykh preparatov na osnove dioksidina i doksitsiklina i ikh effektivnost' pri mastite u korov* [Abstract dissertatsii, Vserossiyskiy Nauchno-Issledovatelskiy Veterinarnyy Institut Patologii, Farmakologii i Terapii]. Voronezh.
10. Kolenchukova, O. A. (n.d.). Osobennosti polirezistentnosti u metitsillinoustoychivykh shtammov stafilokokka pri LOR-zabolevaniyakh.
11. Nasibov, F. N., & Verdiyeva, L. E. (2023). Veterinary obstetrics. *Science and Education*. Baku.
12. Nasibov, F. N., Ahmadov, A. G., & Verdiyeva, L. E. (2014). *Technology and organization of artificial insemination of agricultural animals*, 182.

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The Second Green Revolution: The Role of Biotechnologies in Global Food Security

Abstract

In the context of the rapid growth of the world population, climate change and depletion of natural resources, the issue of global food security has become even more urgent. In these circumstances, the reformation of the agricultural sector and the application of new technological approaches have become a necessity. In this regard, the new era, called the "Second Green Revolution" and based on biotechnology, plays an important role in establishing sustainable and highly productive production models. The development of biotechnology is closely related to the history of technical microbiology and has been observed since ancient times with the use of various microorganisms in food production.

The article also shows that through biotechnological methods it is possible to create varieties of plants and animals resistant to climate change, pests and soil degradation. This allows for increased productivity in local collections, more efficient use of resources and protection from environmental pollution. At the same time, the application of biotechnologies creates legal, social and environmental problems. Accordingly, the creation of legal and institutional mechanisms in accordance with international standards for the management of these technologies, as well as public education is particular importance.

Keywords: *food security, biotechnology, world population, international standard, agriculture*

Introduction

In modern times, the agricultural sector is undergoing a profound transformation on a global scale. If in the middle of the last century, thanks to technological and agronomic changes called the "Green Revolution", productivity was significantly increased and the threat of hunger was partially reduced, this process has now entered a new phase, known as the "Second Green Revolution" or the "Biotechnology Revolution". Although in the previous period, crop production increased with the application of fertilizers, pesticides and irrigation technologies, this approach led to undesirable consequences such as overexploitation of land and water resources, land degradation and the exploitation of ecosystems. The rapid increase in the population of the world and the impact of global climate change have further exacerbated the problem of food shortages.

Research

The rapid growth of the world's population and the impact of global climate change have made the problem of food shortages even more urgent (Secrets Blogspot, 2023).

The world's population is facing many parallel and interacting global problems. Climate change and food shortages are of particular importance here. The 2023 report of the Food and Agriculture Organization of the United Nations (FAO) once again reveals how critical this situation is. Approximately 735 million people in the world are facing food shortages. This means that one in ten people on the planet goes hungry, and this number continues to grow.

Climate change also has a direct impact on private agriculture. Rising temperatures, changing rainfall patterns, and the intensification of extreme weather events such as droughts and floods have led to reduced productivity in many countries. According to the FAO, local crop yields have decreased in 20 countries as a result of climate change. This is particularly acute in sub-Saharan Africa, parts of Asia, and Latin America. On the other hand, the rapid increase in food prices is

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also a global concern. Since 2020, world food prices have increased by more than 35%. One of the main reasons for this increase is climate-related impulses in urban economies and disruptions in supply chains. As a result, part of the population in low-income countries and even in some developed countries is deprived of access to quality and sufficient nutrition (FAO – Food and Agriculture Organization of the United Nations, 2023).

Food insecurity is not only an economic problem, but also a problem with social and political consequences. Food conflicts lead to social tensions, protests, deepening economic instability and, ultimately, forced migration. The mass migration of people from their homelands to cities, and in many cases internationally, shows the social scale of this threat. Therefore, food insecurity is also a serious obstacle to stability and sustainable development. In this situation, a great responsibility falls on states and international organizations. Sustainable agricultural policies, the introduction of climate-adapted production technologies, successful management of water and soil resources, innovations in large areas, support and interregional partnerships are essential conditions for overcoming this problem.

Therefore, there is still a need for more sustainable and environmentally friendly production methods in terms of energy saving. This need emphasizes the need for the application of new technologies, especially biotechnology. Today, biotechnology is considered a strategic tool not only to increase productivity in urban areas, but also to reduce negative environmental impacts and use resources efficiently. Biotechnological approaches allow the creation of plant and animal breeds that are more environmentally sustainable, more adaptable to harsh natural conditions, and more resistant to diseases, thus producing a wide range of products. Thanks to these technologies, new plant varieties are created that are resistant to drought, high and low temperature changes, soil degradation, pests and chemical herbicides.

At the same time, animal species with high adaptability to disasters and climate variability are being bred through genetic engineering methods. These innovations are used to ensure the continuity of production, increase soil fertility and increase the productivity of agricultural areas, especially in lands considered unfavorable and marginal in terms of human resources, and play an indispensable role in improving quality. However, along with all these advantages, there are also potential impacts of the application of biotechnology on the environment, human health and food security, as well as financial and social problems (FAO, 2021). Therefore, the establishment of appropriate legal and institutional frameworks for the production, cultivation and use of biotechnology products has become an important issue. The establishment of effective national control and regulatory systems within each country based on internationally accepted standards and requirements remains one of the main global governance challenges. Decision-making on all scientific principles, including public awareness, plays an important role in the correct and risk-free application of biotechnology.

Taking into account the above and other points, it can be said that biotechnology is a science that studies methods of obtaining substances and products useful for humans under controlled conditions using microorganisms, animal and plant cells, or biological structures isolated from cells. It uses living organisms and biological processes in the practical interests of humans.

The term “biotechnology” was first used in 1917 by the Hungarian engineer Karl Ereki. He used this term to describe the process of feeding pigs using sugar beet feed. According to Ereki, biotechnology is “all work carried out to produce one or another product from raw materials with the help of living organisms”. However, there is still no single and clear position among scientists regarding the concept of “biotechnology”. This is explained by the fact that modern “biotechnology” is not a separate science, but a whole field of knowledge that encompasses biological, exact, etc. fields of science and unites numerous sciences (FAO, 2023).

In 1675, Antoni Van Leeuwenhoek first described microorganisms, marking the beginning of the descriptive era of microbiology. However, there is evidence of beer brewing long before this discovery, dating back to 6000 BC. In ancient times, people used microorganisms to make vinegar, yogurt, cheese, etc. from dairy products, to soften fibrous plants, and to make bread and wine (Alizadeh, 2019).

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Check out the benefits of apples in biotechnology

- It allows the timely detection of epidemics and roadborne diseases that may spread in the future.
- With the application of modern technologies, the preparation of bonds can be implemented more quickly and efficiently.
- It is possible to combat hereditary diseases and reduce their spread.
- Productivity is increased in the field of animal husbandry, and the breeding of breeds that are resistant to diseases is ensured.
- It prevents the preparation of new generation treatment preparations for severe diseases that are difficult to treat.

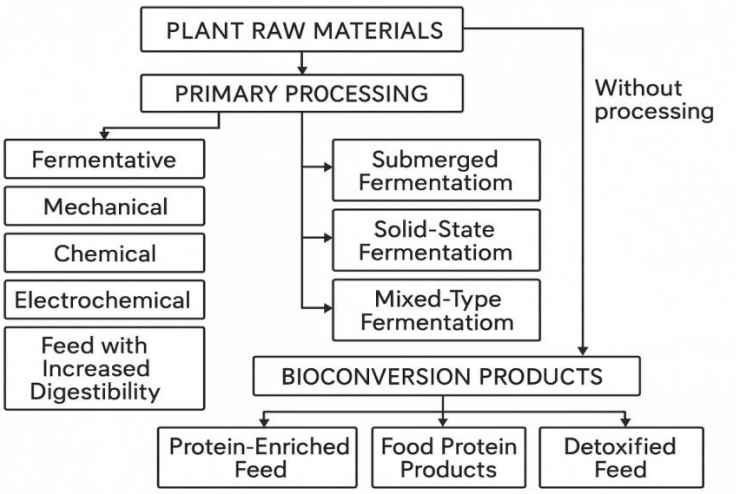
Biotechnology negative effect their potential there are:

- There is a possibility that dangerous biological agents based on living organisms could be used as weapons.
- The production of genetically modified fruit plants may have undesirable consequences for the health and environment.
- As a result of biotechnology activities, there is a risk of discharging harmful and toxic substances into the environment.
- Of course, ecological disasters that have been formed over long years can be created as a result of biotechnological interventions.
- Chemical substances and processes used in biotechnology can cause pollution of air, water and soil.

Unsupervised genetic modifications and modified organisms introduced from the laboratory environment can compromise the stability of ecosystems and jeopardize biological diversity (Secrets Blogspot, 2023).

At present, the processing and understanding of biotechnology is practically essential in the activities of all countries. One of the central tasks in the economic policy of developed countries is to achieve success in biotechnology. Now USA and Japan are leaders in biotechnology and have extensive experience in this field in the field of personal savings, pharmaceuticals, food and chemical industry. Other European countries (AFR, France, Great Britain), as well as Russia has strengthened its position in the production of ferment preparations, amine pickles, zulal, natural preparations. One of the important directions is the extraction of waste and feed products from plant materials through bioconversion (Figure 1.4) (Strategy Roadmap on the production and production of self-made products in the Republic of Azerbaijan, n.d.).

Figure 1.4. Bioconversion scheme of plant raw materials Wikipedia contributors. (n.d.)



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Conclusion

As a result, biotechnologies are likely to play a strategic role in ensuring food safety and provide important opportunities for continuous development in the protection of the ecological environment, but also for future generations. It emerges as one of the main tools in formalizing durable models of self-savings.

The struggle with climate change is not just a matter of ecology, but also a matter of strategy in terms of food safety. For the sake of continuous and successful development, it is necessary to approach these two problems in a complex and integral way.

References

1. Alizadeh, F. (2019). The role of biotechnology in food safety. *Azerbaijan Agrarian Scientific Journal, (3)*.
2. FAO. (2021). *The role of biotechnology in food security and sustainable agriculture*. Food and Agriculture Organization of the United Nations. https://www.fao.org/biotechnology/en
3. FAO. (2023). *The state of food and food safety in the world 2023*. Organization for Food and Livelihood Conservation of the United Nations. https://www.fao.org
4. Strategy Roadmap on the production and production of self-made products in the Republic of Azerbaijan. (n.d.). *E-qanun.az*. https://e-qanun.az/framework/57124
5. National Library of Azerbaijan. (2019). Biotechnology. http://anl.az/el/Kitab/2019/05/2019-83.pdf
6. Wikipedia contributors. (n.d.). Biotechnology. Wikipedia. Retrieved July 17, 2025, from https://az.wikipedia.org/wiki/Biotechnology
7. FAO – Food and Agriculture Organization of the United Nations. (2023). The state of food and food safety in the world 2023. https://www.fao.org
8. Secrets Blogspot. (2023, March). About the Biotechnology https://sirrler.blogspot.com/2023/03/biotexnology.html

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Cortisol and its Role in the Development of Diseases

Abstract

Oxidative stress arises from excessive accumulation of free radicals in the body, imbalanced synthesis of reactive oxygen species (ROS) and disruption of antioxidant defense mechanisms. ROS mainly include oxygen ions (superoxide anion), free radicals, and peroxides derived from mitochondria or NADPH oxidase. Accumulated ROS react with lipids, proteins and DNA, leading to apoptosis and disruption of protein synthesis. Among ROS superoxide anion and hydrogen peroxide, which act as critical messengers initiating changes in cellular signaling, are key mediators in diseases such as atherosclerosis, diabetes, and neurodegenerative disorders.

Keywords: *free radicals, oxidative stress, carbohydrate metabolism, superoxide anion, neurodegenerative diseases*

Introduction

Oxidative stress occurs due to the excessive accumulation of free radicals and disruption of antioxidant defense mechanisms. Contributing factors include environmental pollution, unhealthy diet, radiation, and chronic stress. Free radicals are unstable atoms or molecules with an incomplete outer electron shell, making them highly reactive and capable of capturing electrons from other molecules to stabilize themselves. This imbalance can cause severe cellular problems. Due to their reactivity, free radicals can damage cell membrane structures (Anagnostis, Athyros, Karagiannis & Mikhailidis, 2009), leading to cellular dysfunction and death. Superoxide anion and hydrogen peroxide, acting as key messengers among ROS, are major contributors to diseases like atherosclerosis, diabetes, and neurodegeneration. Additionally, ROS causes oxidation within cells and reduces antioxidant defenses. Through their various effects, reactive oxygen species play a significant role in human pathophysiology by promoting cell proliferation, tumor development and cell death in degenerative disorders of the central nervous system (Knezevich, Nenich & Milanovich, 2023).

Research

Cortisol is chemically classified as a pregnene-triol-dione. By specifying the positions of substituents on the molecule and the carbon atoms they bind to, cortisol can be defined as delta4-pregnene-11beta,17alpha,21-triol-3,20-dione. In the side chain and ring carbons, there is no alpha or beta orientation for the keto groups (Figure 1).

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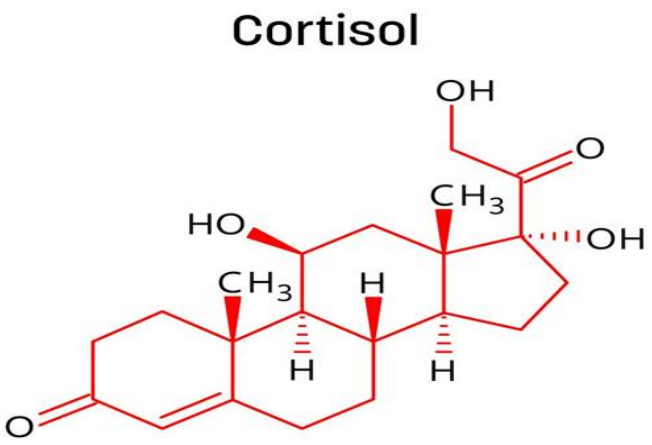

Figure 1. Biochemical structure of cortisol

Cortisol has two main functions: promoting the breakdown of proteins and fats to provide metabolites convertible to glucose in the liver, and activating antistress and anti-inflammatory pathways. By increasing gluconeogenesis and inhibiting glucose uptake in tissues other than the central nervous system, cortisol helps maintain blood glucose levels (Akalestou, Genser & Rutter, 2020). Thus, oxidative stress can lead to acute and chronic diseases.

Cancer: Cancer refers to the abnormal proliferation of cells forming new tissues in organs or tissues. Oxidative stress can directly damage various molecules in the body, including DNA. Persistent oxidative stress leads to DNA damage, potentially resulting in uncontrolled cell growth. Major cancer types caused by oxidative stress include breast and prostate cancers.

Cardiovascular diseases: Oxidative stress promotes the formation of cholesterol plaques in blood vessels, which can lead to cardiovascular diseases and atherosclerosis over time. Chronic stress increases blood pressure, and blood returns to the heart with higher force, affecting the heart muscle wall. Over time, this causes thickening of the heart muscle, known as left ventricular hypertrophy, which leads to irregular heartbeats. In general, chronic stress elevates blood pressure and damages specific areas of arteries. Immune cells targeting inflammation focus on these damaged areas (Chayakar, 2021).

Diabetes mellitus: Diabetes develops when the pancreas fails to produce enough insulin or when insulin is not effectively used. Oxidative stress can damage the pancreas, leading to insufficient or ineffective insulin function.

Inflammatory processes: Oxidative stress can lead to inflammation of joints and surrounding tissues, contributing to the development of rheumatoid arthritis.

Neurodegenerative disorders: Prolonged oxidative stress may damage the central nervous system, leading to disorders such as Alzheimer's, Parkinson's disease, amyotrophic lateral sclerosis (ALS), memory loss, and depression. These diseases are linked to elevated cortisol production during stress, which accelerates aging and disease onset. Numerous studies show a relationship between chronic stress, poor health outcomes, and risk factors such as cardiovascular diseases and impaired immune function. However, the exact mechanisms by which stress exerts these effects, particularly whether it accelerates aging at the cellular level and how this translates into organismal aging, remain unclear. Recent research indicates that telomeres and telomerase play a crucial role in cellular aging and potentially in disease development. Telomeres are DNA-protein complexes that ensure chromosome stability. During cell division, due to limitations in DNA polymerase activity, telomeres are not fully replicated, leading to shortening with each replication. In vitro, once telomeres shorten sufficiently, the cell enters senescence. In humans, telomeres shorten with age in all studied proliferative somatic cells, including fibroblasts and leukocytes. The cellular environment plays a significant role in regulating telomere length and telomerase activity. Importantly, oxidative stress can shorten telomeres in vitro, while antioxidants may slow this shortening (Zhang, Lai, Chen, Zhang & Liu, 2023). Stress has been associated with oxidative DNA

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damage in leukocytes in women. Considering these findings, chronic psychological stress may lead to telomere shortening, decreased telomerase activity in peripheral blood mononuclear cells, and increased oxidative stress (Henley, Lightman & Carrell, 2016). Alongside other glucocorticoids, cortisol is known to exert potent anti-inflammatory effects at pharmacological levels. Therefore, glucocorticoid drugs are currently used in the treatment of many inflammatory diseases. They are commonly prescribed to patients with lymphoid cancers such as lymphomas, leukemia, and myelomas (Lauren & Kevin, 2020).

Effects on protein metabolism: Cortisol has primarily catabolic effects, inhibiting DNA synthesis, increasing protein breakdown, and promoting nitrogen excretion. Cortisol deficiency does not significantly enhance protein synthesis, but excess cortisol leads to progressive protein loss in muscles, muscle weakness, and atrophy. Cortisol also limits glucose utilization in all body cells (Figure 2).

Effects on fat metabolism: Hormones that mobilize lipids increase cellular lipase activity, regulating fatty acid metabolism. Cortisol accelerates the release of fatty acids into the bloodstream from tissues, increasing their plasma concentration and utilization as an energy source. This effect is linked to reduced glucose transport into adipocytes, which require glucose-derived α-glycerophosphate for triglyceride storage. In its absence, fatty acids begin to be released from adipose tissue (Vignesh, Castro-Dominguez, James, Gamble-Turner, Lightman & Reis, 2024).

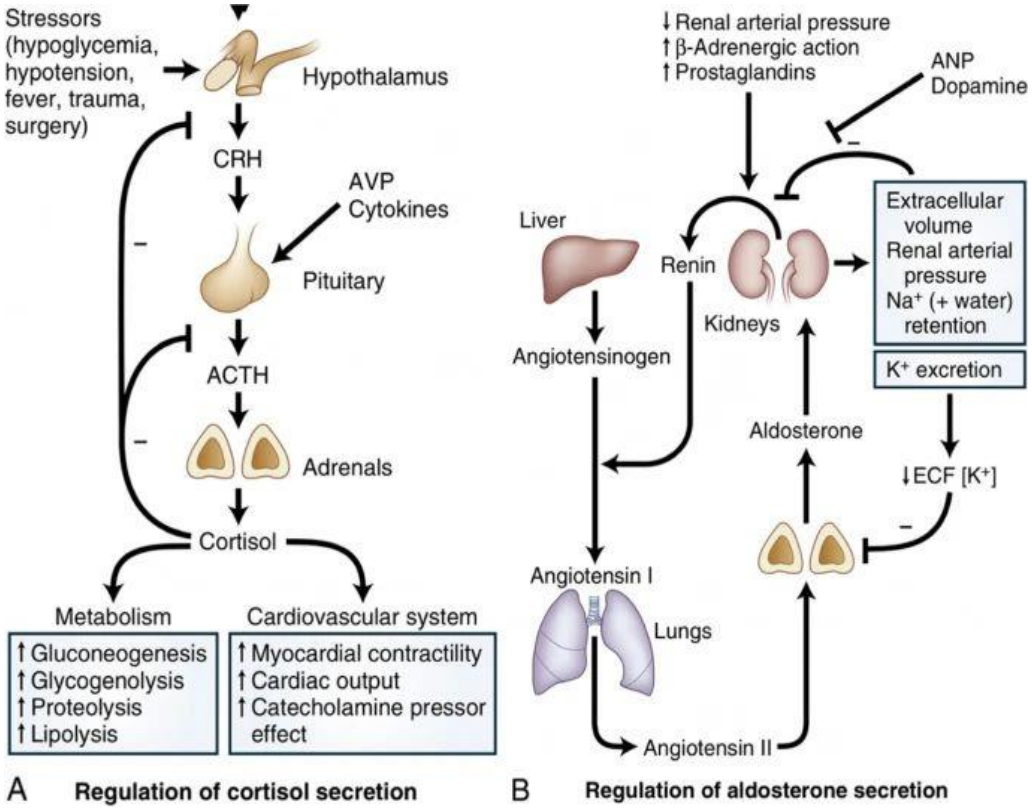

Figure 2. Synthesis, regulation of synthesis, and biochemical effects of glucocorticoids

Conclusion

At the cellular level, glucocorticoids inhibit the synthesis and action of inflammatory cytokines. At high doses, they can suppress immune system functions by reducing cell-mediated immune responses and immunoglobulin synthesis and activity. However, high-dose glucocorticoids have serious side effects. Oxidative stress negatively impacts human health, with symptoms including chronic fatigue, premature skin aging, circulatory disorders and insomnia. Oxidative stress can contribute to both acute and chronic diseases.

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References

1. Anagnostis, P., Athyros, V, Karagiannis, A., Mikhailidis, P (2009). The pathogenetic role of cortisol in the metabolic syndrome: a hypothesis. *The Journal of Clinical Endocrinology & Metabolism*, 94(8), 2692-2701.
2. Akalestou, E., Genser, L., Rutter, G. (2020). Glucocorticoid metabolism in obesity and following weight loss. *Frontiers in endocrinology*, 11, 59.
3. Chayakar, A. (2021). The use of steroids in clinical practice. Journal of the Turkish Society of Rheumatology, 13(2).
4. Henley, D., Lightman, S., Carrell, R. (2016). Cortisol and CBG—Getting cortisol to the right place at the right time. *Journal of the Pharmacology & herapeutics*, 166, 128-135.
5. Knezevich, E., Nenich, K., Milanovich, V., Knezevich, N. (2023). The role of cortisol in chronic stress, neurodegenerative diseases, and psychological disorders, 12(23), 2726.
6. Lauren V., Kevin B., (2020). *Encyclopedia of Evolutionary Psychological Science, Springer Nature Switzerland AG.*
7. Vignesh, V., Castro-Dominguez, B., James, T., Gamble-Turner, J., Lightman, S., & Reis, N. (2024). Advancements in cortisol detection: from conventional methods to next-generation technologies for enhanced hormone monitoring. *ACS sensors*, 9(4), 1666-1681.
8. Zhang, Y., Lai, Q., Chen, W., Zhang, C., Mo, L., & Liu, Z. (2023). Recent advance in cortisol immunosensing technologies and devices. Chemosensors, 11(2), 90.

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Adapting California Almond Farming Practices to Azerbaijani Conditions: Opportunities and Constraints

Abstract

Azerbaijan's almond sector is gaining momentum, supported by favorable agro-ecological zones and rising global demand. In contrast, California—producing nearly 80% of the world's almonds—benefits from decades of refinement in orchard design, irrigation, cultivar selection, bloom synchronization, and mechanized harvesting. This study explores how California's model can inform the transformation of Azerbaijan's predominantly artisanal almond cultivation. Using climate and soil comparisons, literature synthesis, and expert interviews, we identify California practices with the highest local adaptation potential: drip and regulated deficit irrigation (RDI), late-blooming cultivars, integrated pest management (IPM), and mechanized harvesting. Implementation, however, faces barriers such as inadequate water infrastructure, limited nursery certification, fragmented landholdings, and gaps in technical capacity. We conclude with recommendations for policy support and investment strategies to enable sustainable almond development in Azerbaijan.

Keywords: *Almond cultivation, Azerbaijan, California model, Drip irrigation, Deficit irrigation, Late-blooming cultivars, IPM, Mechanization, Climate resilience*

Introduction

Almonds (*Prunus dulcis*) are prized for their nutritional content, profitability and adaptability to semi-arid climates. Global consumption—particularly in Asia and Europe—continues to rise, with California emerging as the world's leading producer due to its efficient use of technology, infrastructure, and institutional support (FAO, 2023). Central to this success are high-density orchards, self-compatible and late-blooming cultivars, micro-managed irrigation, bloom regulation techniques, and extensive mechanization (Shahverdiyev, & Yusifli, 2020).

Research

In Azerbaijan, almonds grow well in regions with 400+ chilling hours, favorable soils and low humidity—conditions reminiscent of California's Central Valley. However, most Azerbaijani production remains traditional, with low yields and limited scalability (Aliyev et al., 2019). By studying California's evolution, this paper aims to identify feasible agronomic practices and the support systems needed to adapt them locally (DeJong, Day, & Weinbaum, 2006).

We address the following objectives (Tanriverdi, & Erkan, 2021):

1. Highlight key Californian innovations in almond production;
2. Assess their agro-climatic and economic fit for Azerbaijan;
3. Propose policies and investments to promote adaptation and scale-up.

4. Materials & Methods

4.1 Scope

The study compares Central California's almond belt and Azerbaijan's main almond-growing regions, focusing on agro-climatic features, infrastructure, institutional readiness, and economic viability (Ayers, & Westcot, 1985).

4.2 Target Zones

We examined Azerbaijani regions with loamy soils, semi-arid climate, and winter chill accumulation (400–800 hours), primarily in the Absheron Peninsula, and other almond-growing zones of Azerbaijan (Connell, 2002).

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4.3 Data Collection

Data from 2022–2024 were collected from national meteorological and soil databases, UC Davis/USDA research, FAO statistics, and technical documents (Zhang, Wang, & Xu, 2019). We also conducted interviews with Azerbaijani agronomists and growers. SWOT analysis was used to assess feasibility (Ferguson, & Sibbet, 2008).

4.4 Assessment Criteria

Each Californian innovation was evaluated for:

- Climatic and soil compatibility
- Water and energy requirements
- Technical and financial feasibility
- Farm size suitability and local adoption potential

5. Results and Discussion

5.1 Orchard Design

California uses super-high-density planting systems (5.5 × 6.5 m or tighter) with over 1,000 trees per hectare to increase yields and mechanization compatibility (Lampinen et al., 2011). In Azerbaijan, flat lands could support similar layouts, but fragmented plots and smallholder structures limit adoption without cooperative models (Ramesh & Chandel, 2022).

5.2 Irrigation Techniques

Drip and RDI have revolutionized California's water use efficiency, reducing applied water by over 30% while maintaining yields (Goldhamer & Fereres, 2017). Azerbaijani orchards mostly rely on surface and manual irrigation, contributing to water waste and salinization risks.

Table 1. Comparison of Irrigation Practices

Parameter	California	Azerbaijan
Dominant System	Drip + Regulated Deficit	Manual / Surface
Efficiency (WUE)	High (up to 90% ETc)	Low (<50% ETc)
Constraints	Initial capital, sensors	Infrastructure, training

5.3 Cultivar Performance

Late-flowering, self-compatible cultivars such as 'Independence' and 'Shasta' outperform traditional landraces in frost-prone zones (Gradziel & Lampinen, 2020). Trials in Azerbaijan indicate compatibility, pending nursery upgrades and disease certification (Sharifov et al., 2021).

5.4 Bloom Delay & Frost Protection

California growers reduce frost exposure via delayed pruning and bloom regulators (DeJong et al., 2006). In Azerbaijan, chemical regulators are not widely used and late-pruning methods require training and regional calibration (Kallsen, & Parfitt, 2017; Pérez-Pastor, Ruiz-Sánchez, Domingo, & Torrecillas, 2009).

5.5 Pest and Disease Control

California implements IPM protocols combining monitoring, thresholds, biological agents and targeted sprays (Haviland et al., 2020). Azerbaijan's pest control is predominantly calendar-based (Goldhamer, & Fereres, 2001).

Table 2. Comparison of IPM Practices

Component	California IPM	Azerbaijan Methods
Monitoring	Trap-based, data-driven	Routine, unscheduled
Biological Tools	Widely applied	Rarely used
Training	Extensive extension network	Limited availability

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5.6 Mechanized Harvesting

California uses shake-and-sweep machines to harvest almonds quickly, reducing labor costs and postharvest losses. Azerbaijani growers rely on manual collection, which limits scalability. Group machinery ownership could enhance access and reduce costs (Riazi et al., 2019; Esparza, DeJong, Weinbaum, & Klein, 2001).

Summary Table of Key Comparisons

Feature	California Model	Azerbaijani Potential	Limiting Factors
Cultivars	Self-fertile, late bloom	Compatible climate	Nursery certification
Irrigation	Drip, RDI	Promising	Infrastructure, capital access
IPM	Data-driven, extensive	Emerging interest	Knowledge, training
Mechanization	Highly developed	Moderate potential	Plot fragmentation

Policy and Investment Recommendations

1. Develop demonstration orchards showcasing modern techniques.
2. Certify local nurseries to propagate late-blooming cultivars.
3. Subsidize irrigation infrastructure and mechanization tools.
4. Expand extension programs with IPM and irrigation modules.
5. Foster farmer cooperatives for shared equipment.
6. Promote partnerships with international horticultural centers.

Conclusion

Azerbaijan's almond sector is positioned to benefit from a tailored adaptation of California's cultivation model. Adoption of drip and deficit irrigation, late-blooming cultivars, integrated pest management, and selective mechanization can enhance productivity and climate resilience. However, sustained policy support, coordinated investments, and technical education are essential to realize this potential and establish Azerbaijan as a competitive almond producer.

References

1. Aliyev, A. R., Hasanov, M. S., & Jafarov, A. I. (2019). Potential for fruit crop development in arid zones of Azerbaijan. *Acta Horticulturae, 1256*, 221–228.
2. Ayers, R. S., & Westcot, D. W. (1985). *Water quality for agriculture* (FAO Irrigation and Drainage Paper No. 29 Rev.1). Food and Agriculture Organization.
3. Connell, J. H. (2002). Flowering, pollination and fruit set in almond. *Acta Horticulturae, 591*, 191–198.
4. DeJong, T. M., Day, K. R., & Weinbaum, S. A. (2006). Effects of pruning and crop load on flowering in almonds. *HortScience, 41*(2), 400–404.
5. FAO. (2023). *FAOSTAT production statistics*. https://www.fao.org/faostat/
6. Ferguson, L., & Sibbet, G. S. (2008). *Almond production manual* (Publication No. 3364). University of California Agriculture and Natural Resources.
7. Goldhamer, D. A., & Fereres, E. (2001). Irrigation scheduling protocols using continuously recorded trunk diameter measurements. *Irrigation Science, 20*, 115–125.
8. Gradziel, T. M., & Lampinen, B. D. (2020). Genetic strategies to reduce frost damage and enhance self-compatibility in almonds. *Scientia Horticulturae, 261*, 108978.
9. Haviland, D. R., Bentley, W. J., & Godfrey, K. E. (2020). *Integrated pest management for almonds* (UCANR Publication 3512). University of California Agriculture and Natural Resources.
10. Kallsen, C. E., & Parfitt, D. E. (2017). Almond cultivar development: Past and future. *Horticultural Reviews, 45*, 1–44.

ISSN: 2707-1146
e-ISSN: 2709-4189

11. Lampinen, B. D., Duncan, R. A., & Grattan, S. R. (2011). Orchard spacing and canopy management in almond. *California Agriculture, 65*(1), 10–15.
12. Shahverdiyev, S. R., & Yusifli, H. A. (2020). Evaluation of drought tolerance in fruit crops of Azerbaijan. *Journal of Central Asian Agriculture, 7*(2), 55–64.
13. Sharifov, F. R., Mammadov, Z. H., & Rustamov, E. A. (2021). Grafting experiments on promising almond cultivars in semi-arid zones of Azerbaijan. *Agricultural Research, 14*(3), 231–239.
14. Tanriverdi, R., & Erkan, M. (2021). Effects of deficit irrigation on almond yield and water productivity under Mediterranean conditions. *Irrigation Science, 39*, 517–528.
15. Zhang, H., Wang, Y., & Xu, X. (2019). Mechanized almond harvesting systems: Innovations and constraints. *Biosystems Engineering, 184*, 52–65.
16. Pérez-Pastor, A., Ruiz-Sánchez, M. C., Domingo, R., & Torrecillas, A. (2009). Growth and water use of almond trees under regulated deficit irrigation. *Irrigation Science, 27*(3), 175–184.
17. Esparza, G., DeJong, T. M., Weinbaum, S. A., & Klein, I. (2001). Effects of irrigation timing on shoot growth and dry weight partitioning in almond trees. *Tree Physiology, 21*(2–3), 225–232.

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